Groundwater Management Models and the Courts

- Observations about Groundwater Management, Models, and the Courts – *applies to surface water too*
- Examples
- Dealing with Montana's Groundwater Future

Models *vs* Management

- Common modeling practice at odds with groundwater management needs
- Models as implemented fail to be useful management tools – *over tuned*
- Twist of irony
  - Mangers need models
  - Models create as many headaches as answers
  - Create feeding frenzy for lawyers

Short History of Models

- Models were developed to help understand the dynamics of groundwater systems (60's – 70's)
  - Accuracy with scientifically defensible structure
- Original uses included
  - Testing conceptual models
  - Trouble shooting unpredicted behavior
  - Basin level studies of general behavior
  - Filling out concepts about aquifer structure
  - *Not* held up as providing answer – just a tool

Short History of Models (cont)

- With advent of PC's models migrated to smaller scale problems
  - Contaminant migration
  - Drainage
- Toxic Tort and Regulatory involvement led to demand for greater precision
- Precise hydraulic head matching become defacto standard of a "good" model

Short History of Models (cont)

- Groundwater models become an end unto themselves as concern for precision dominates

- Models become less useful as they gain precision because they lose accuracy (static *vs* dynamic)

Shorter History of Groundwater Management

- Active groundwater management almost always developed in response to court decision or threat
- Early management attempts frequently began with enabling legislation
  - Early legislation normally limited to allocating water
  - Management following legislation subsequently limited further by courts (works as long as there is enough water)
- As competition for resource increases, courts become more decisive, decisions in Federal Courts begin to dominate

Courts

- Courts are playground of attorneys backed by $$$
- Defensive efforts tend to be poorly funded
- Conflicts over water increase as competition for all resources increase - more court involvement
- State courts tend to try to maintain the status quo
- Federal courts become the venue to break the status quo – indirect approaches

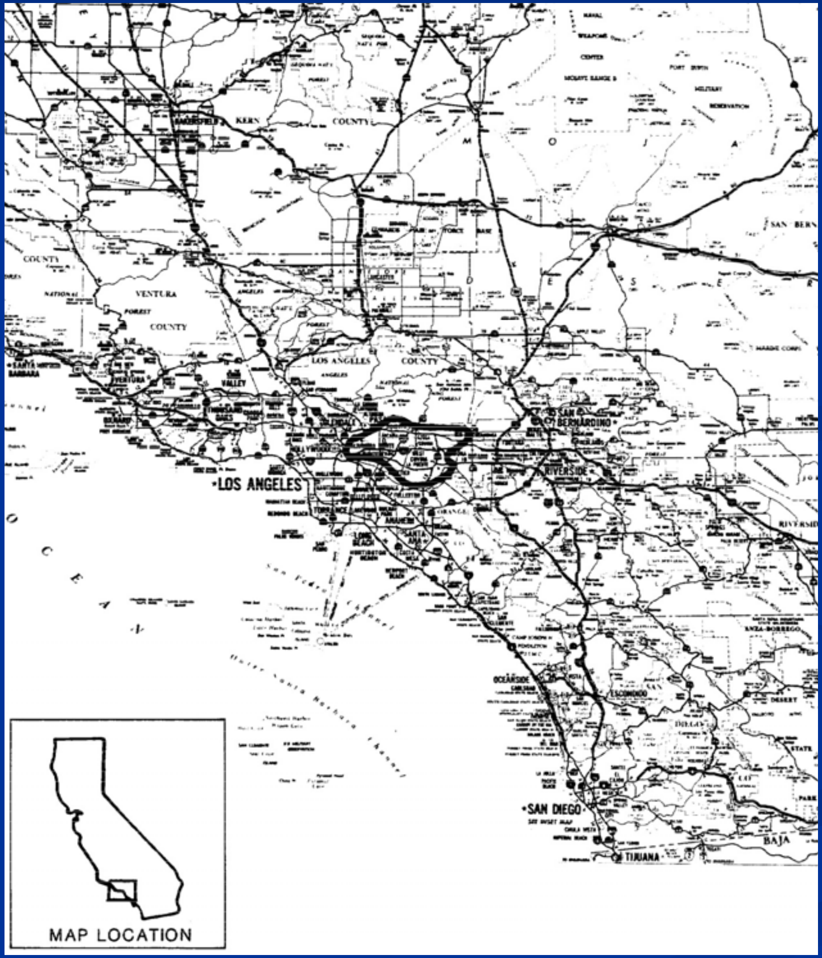
Examples

- San Gabriel Basin – Southern California
- Edwards Aquifer – Texas (San Antonio)

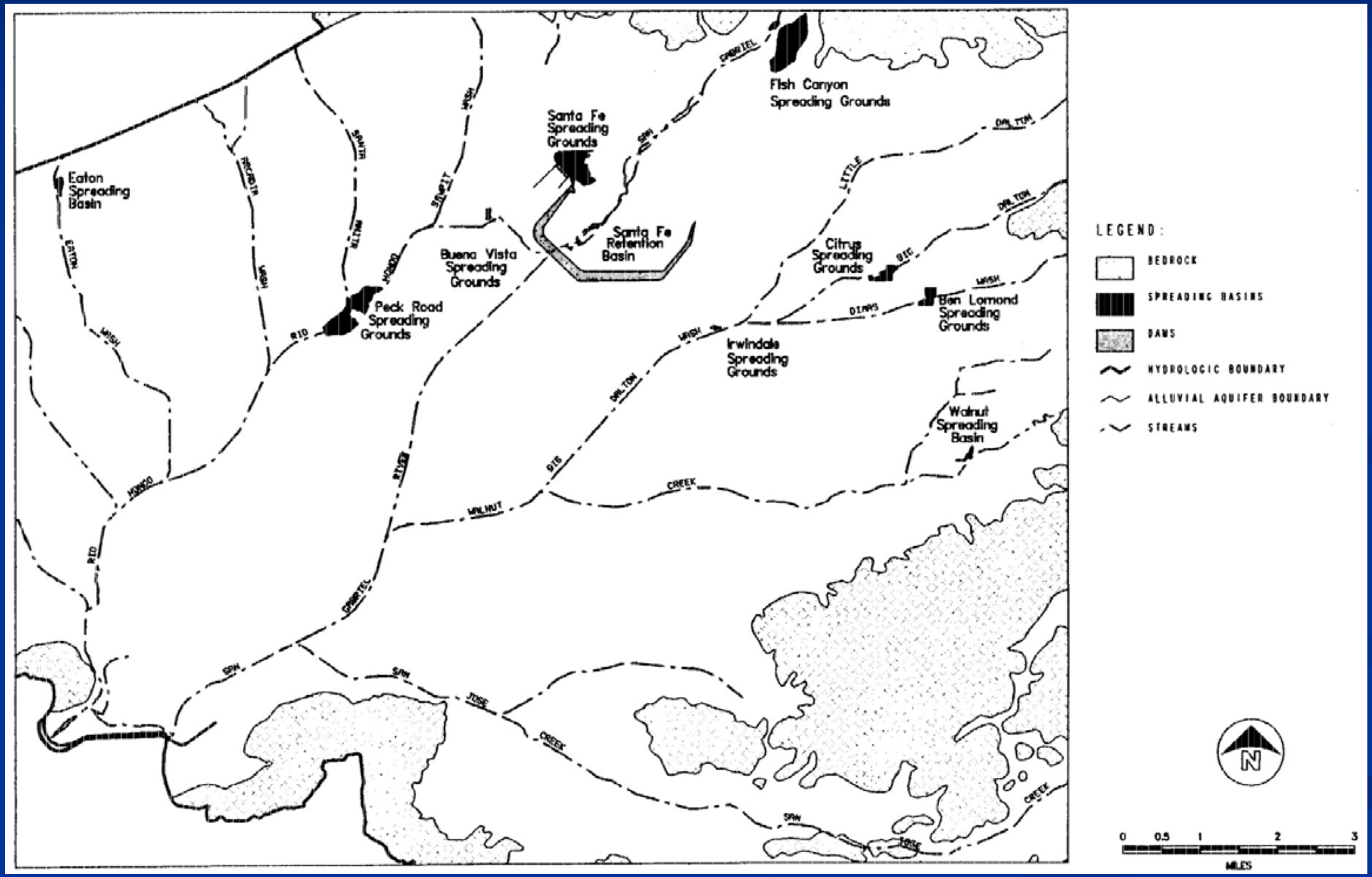
San Gabriel Basin

- Deep sediment filled basin bound by bedrock
- 1,000,000 acre feet within basin sediments
  - Most recharge is local from San Gabriel Mountains
  - Imported Colorado River water recharged as well
- Principle source of water for 1,000,000+ people
- Most of the basin sediment surface is covered with urban development

San Gabriel Basin Location



San Gabriel Basin Surface Hydrologic Features



San Gabriel Basin Groundwater Management

- 1940/50's interbasin transfers of groundwater result in court fight
- Court appointed "Water Master" manages water allocating to major water suppliers/users
- Single sentinel well at Whitter Narrows is used to monitor water levels – data used to calculate how much water moves down gradient to next basin (based on Court order)

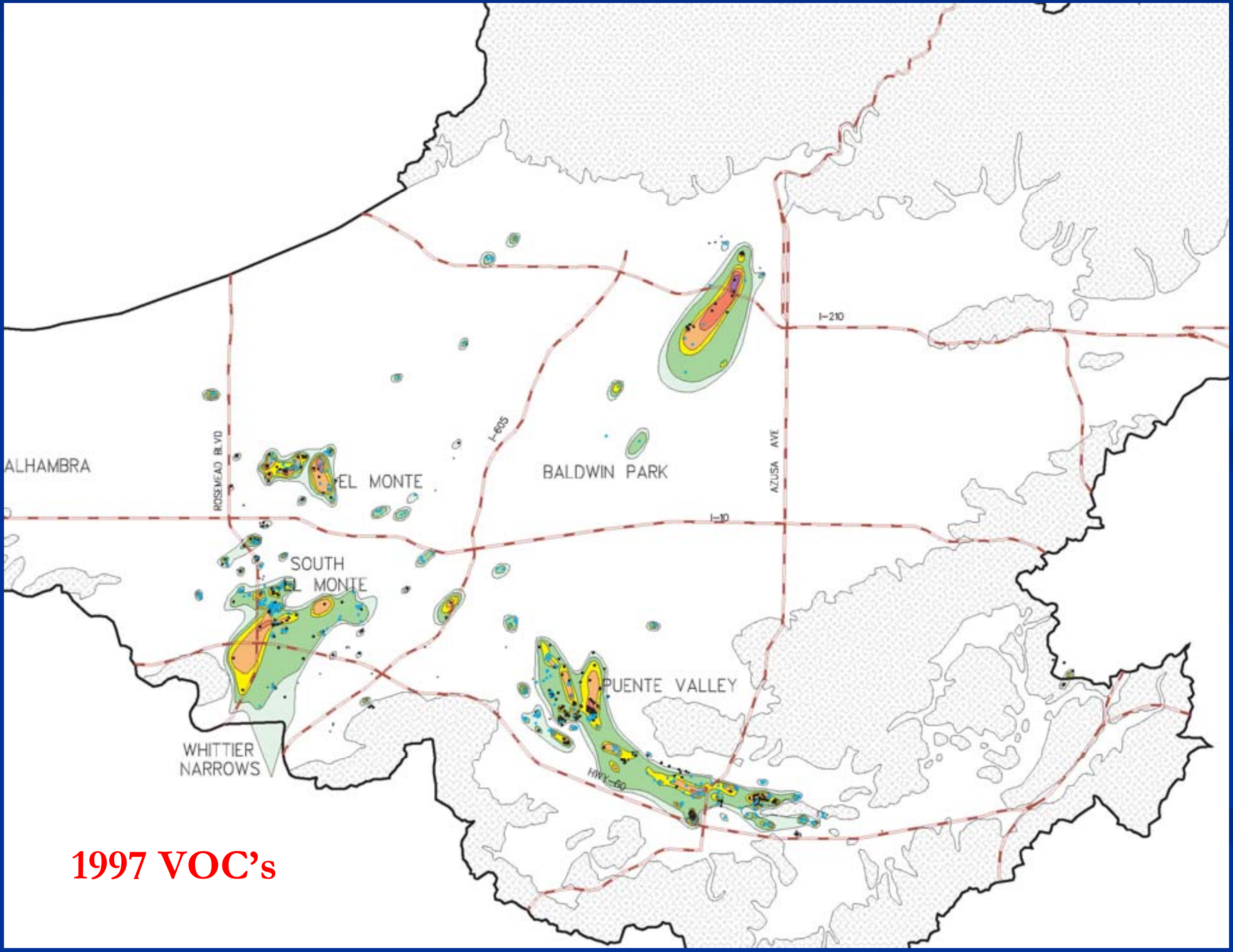
San Gabriel Basin Groundwater Management (cont)

- 1970/80's VOC contamination appears in wells
- Water Master begins to authorize moving wells
  - Most common practice of blending water to meet water quality criteria is increasingly insufficient
- Water Master begins to authorize pumping from deeper levels
  - Contaminated groundwater obliges and follows deeper pumping

San Gabriel Basin Groundwater Management (cont)

- Regulatory action lags
- Feds – EPA steps in begins issuing orders
  - Splits basin into a series of operable units; IDs PRPs
  - Everyone hides behind lawsuits
  - Nothing happens
  - Years pass
- Water Master continues it's usual practices
- State creates new agency to coordinates clean-ups
- Nothing happens

San Gabriel Basin Groundwater Management (cont)



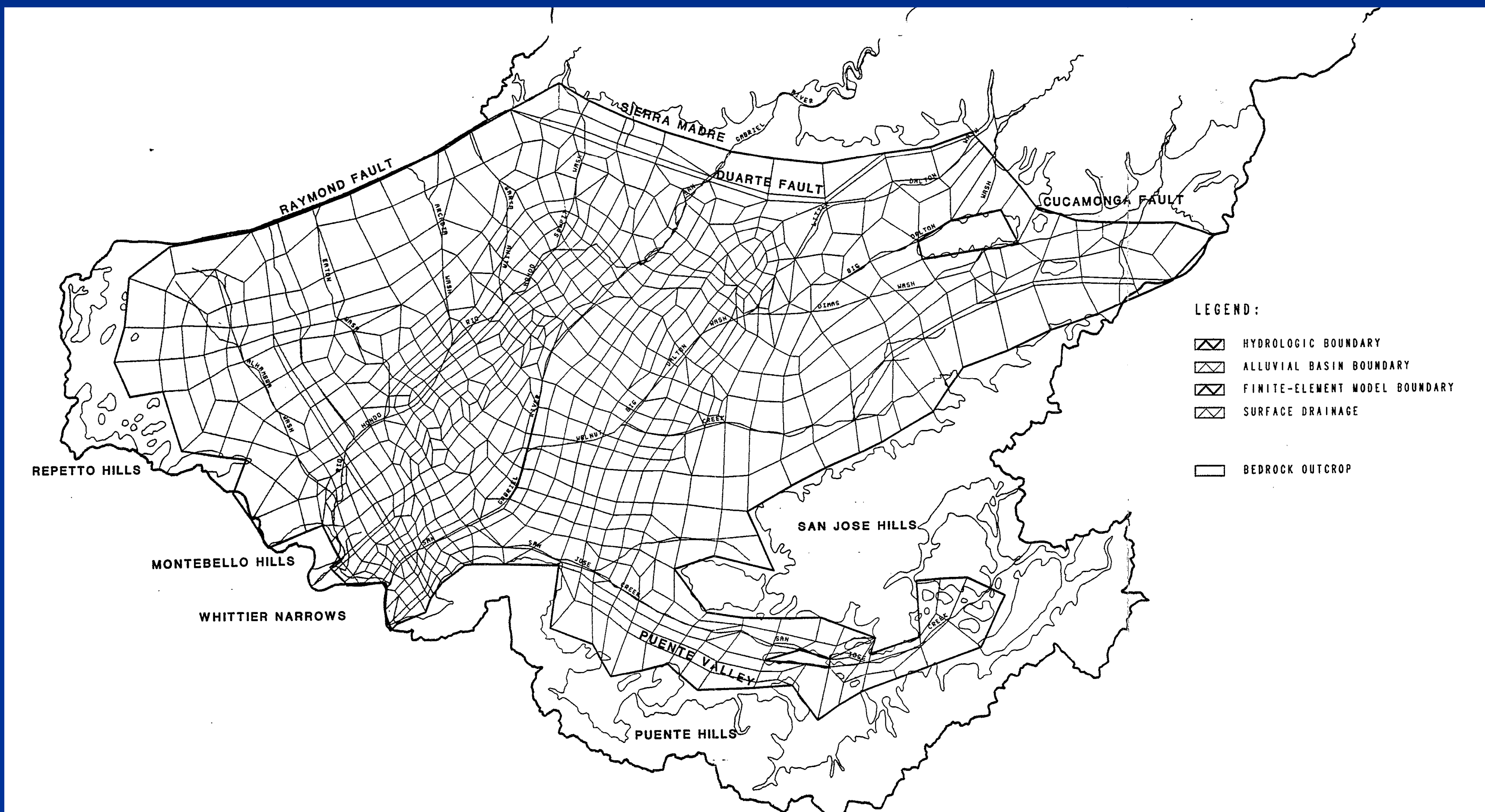
San Gabriel Basin Groundwater Management (cont)

- EPA actions finally spur studies
  - Each PRP Group commissions studies
- Groundwater models developed by each Group
- All the models purport to model entire basin
  - Each model focuses on operable unit contamination
  - Each model uses same hydraulic head data set for calibration
  - Each model demonstrate successful calibration

San Gabriel Basin Groundwater Management (cont)

- But each model is structured differently, so …
  - How do they calibrate to the same data set?
- Two examples:
  - Whittier Narrows OU
  - Baldwin Park OU

San Gabriel Basin Groundwater Management (cont)



San Gabriel Basin Groundwater Management (cont)

- EPA uses CFEST code on Whitter Narrows and Baldwin Park
  - Uses hydraulic conductivities of 20, 25, 50, 100, 200, 300 ft/day
- Baldwin Park PRPs use Dynflow & Dyntrack
  - Uses hydraulic conductivities of 1.5, 1.7, 10, 15, 20, 25, 30, 40, 50, 60, 105, 175, 300, 400 ft/day
- Both use different values/pattern of storage
- Both use different vertical/horizontal ratios

San Gabriel Basin Groundwater Management (cont)

- Both model transport
- Both models use multiple layers (10 typical)
- Both models illustrate very similar calibration
- The point?….

Nonuniqueness

San Gabriel Basin Groundwater Management (cont)

- In order to successfully emulate historic local contaminant transport and local hydraulic heads each model
  - Uses different finite element grid constructs
  - Uses different parameters and parameter distribution
  - Get the same calibration result, but different transport result
  - Too many competing models with different results – lose credibility

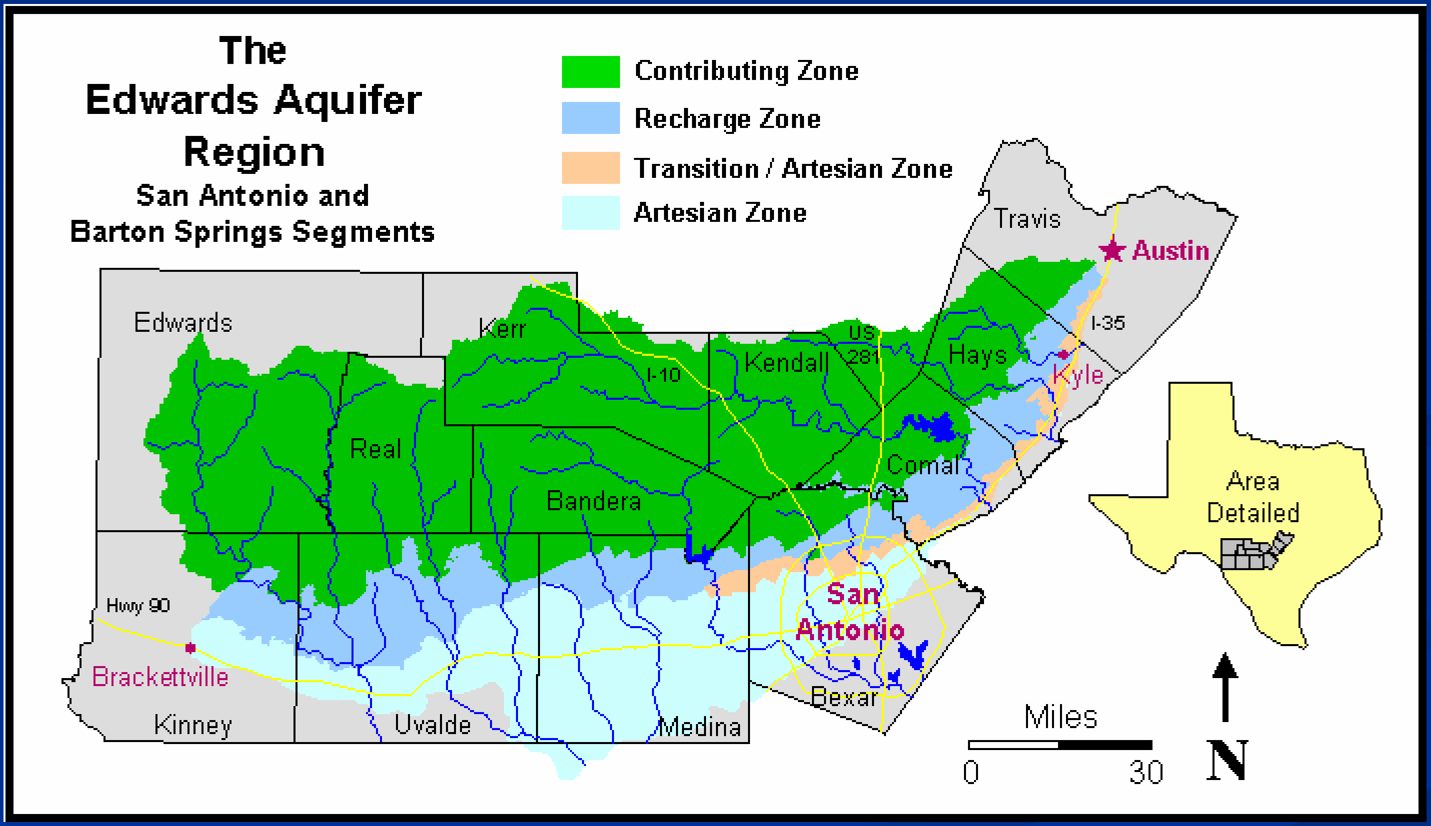
San Gabriel Basin Groundwater Management (cont)

- Since models are all different – none are useful for basin wide management (or legal fights)
- Ineffective science fades into the background – decisions get made in the vacuum
- 100's Millions in water treatment systems are designed and implemented without benefit of effective basin wide model or management plan
- 2002 – EPA abandons all models (including their own) and starts over with a FEFLOW model of the basin for internal use

Edwards Aquifer

- Karst aquifer
- Recharge tends to be from precipitation on outcrop and "contributory" areas
- 4-5 million acre feet of water
- Water supply for 1.4 million in San Antonio area
- Mixed urban, irrigated agriculture, range
- Edwards Aquifer Authority created to manage limited a reach of the aquifer

Edwards Aquifer Location



Edwards Aquifer Management Models

- 1979 – Texas Water Development Board Finite Difference Model (1992 refined)
- 1983- Discrete State Compartment Model
- 1988 USGS Finite Difference Model
- 1992 Lumped Parameter Model
- 1993 Texas A&M Economic/Hydrologic Model
- 1994 USGS Finite Element Model
- 1995 Edwards Aquifer Underground Water District Simulation Model
- 1999 Bureau of Economic Geology 3D Virtual Reality Model
- 2002 Edwards Aquifer Authority (EAA) Models –
  - Modflow approaches
  - SWRI Modflow with Fast Pathway module

Edwards Aquifer and the Courts

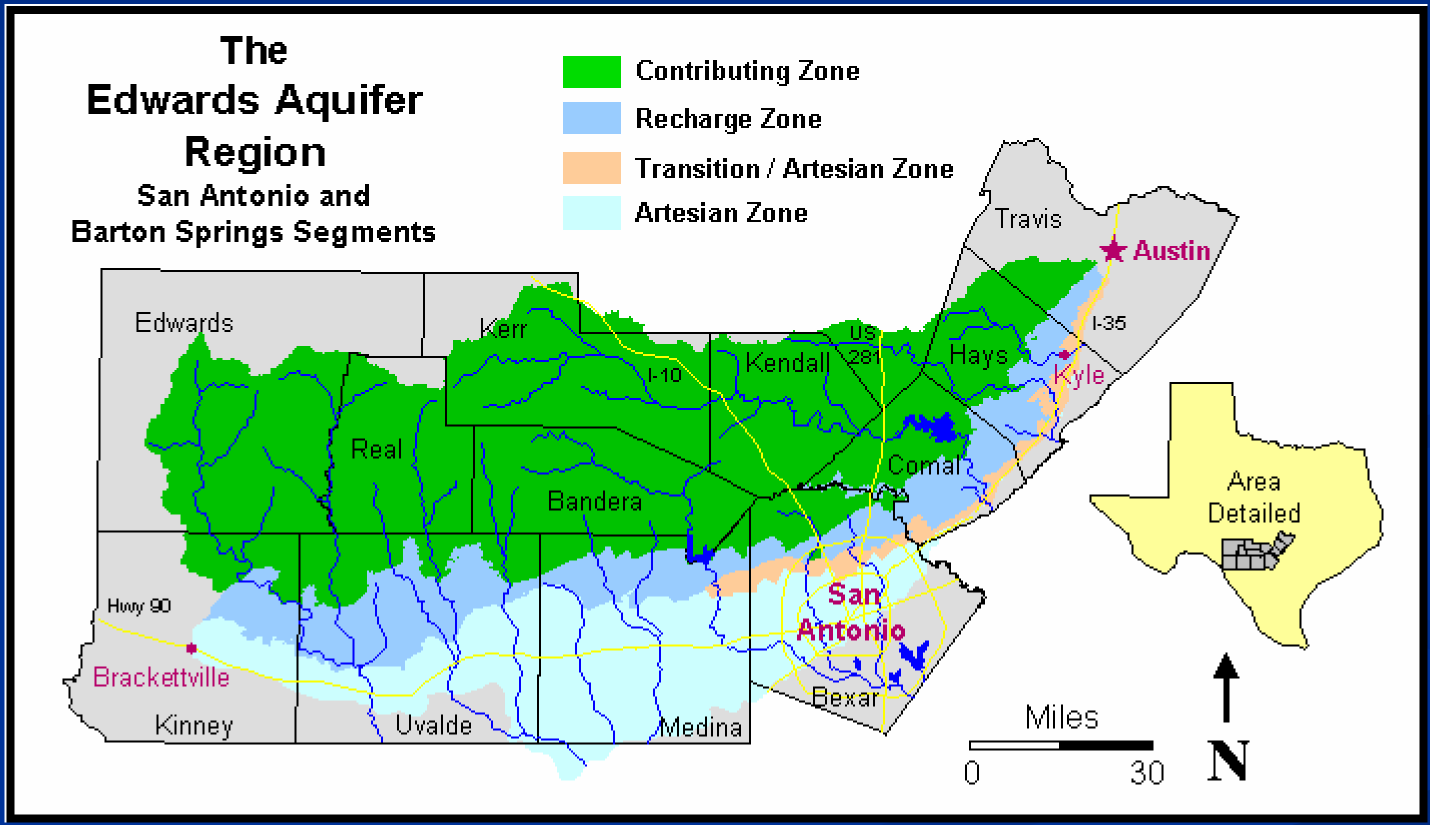
- Active groundwater management of the Edwards is a study in Court mandated Management
- EAA created in response to a suit over alleged voter rights violations (huh?)

- But first the main legal events…

Edwards Aquifer and the Courts (cont)

- Sierra Club sues USFWS over Endangered Species
  - Minimum spring flows at Comel and San Marcos Springs to protect species unique to springs
  - Suit brought in Federal Court – skip state courts
- Sierra Club sues USDA over support of agricultural irrigation practices – effect on minimum spring flows

Edwards Aquifer and the Courts (cont)



Edwards Aquifer and the Courts (cont)

- Courts limit Edwards groundwater extraction
- Texas legislature enacts limits
  - 450,000 acre feet annually
  - 400,000 acre feet after 2012
- Texas citizens sue state over "taking" issue – and lose

Edwards Aquifer and the Courts (cont)

- Sierra Club sues City of San Antonio
  - Attempts to form "class" of all domestic & private well owners in effort to limit individual use of groundwater
  - Sierra Club fails
- EAA senses the inevitable and develops rules limiting domestic/private groundwater use
- EAA feels need to get ahead of momentum

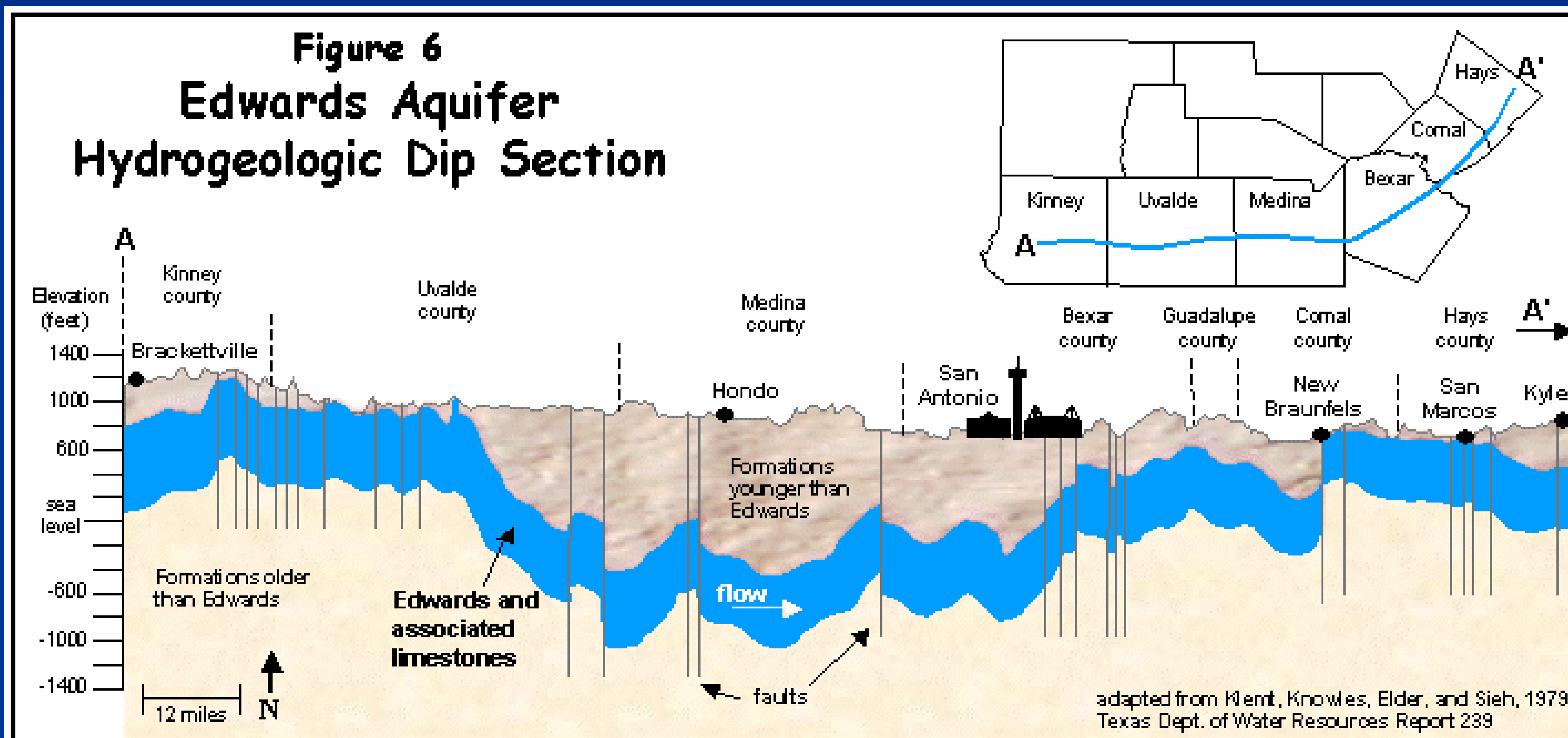
EAA Management

- Regulate Edwards Aquifer groundwater use
- EAA & SAWS embark on major PR campaigns
- Begin search for new sources of water
- May exceed the 450,000 acre foot limit if scientific evidence indicates more water available from aquifer
- Renewed modeling efforts
  - Is aquifer storage and recovery an option?
  - Is water balance accurate?
  - Increased recharge and storage possible?

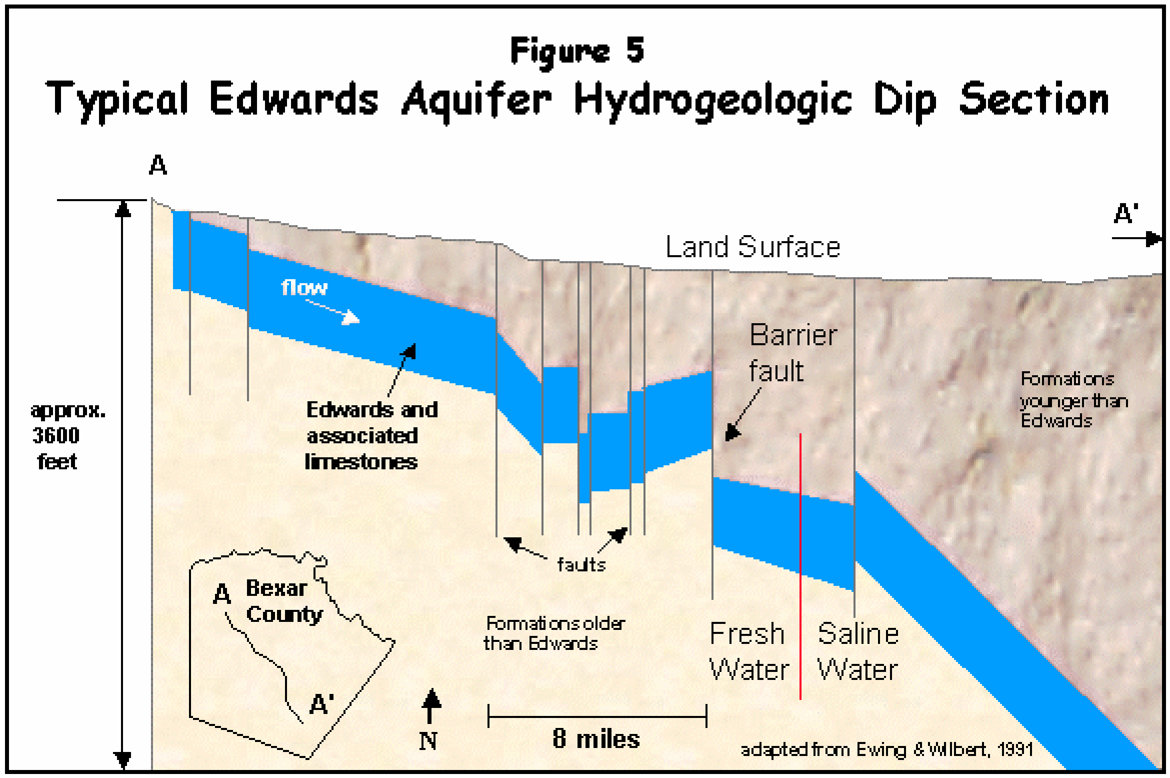
EAA Management (cont)

- Model problems arise
  - Good head matches possible but then springs flows are poor match
  - Good match with spring flows leads to poor head matches to the southwest
  - Water balance issues
  - To meet management needs, model should use daily time steps – decisions made on daily basis

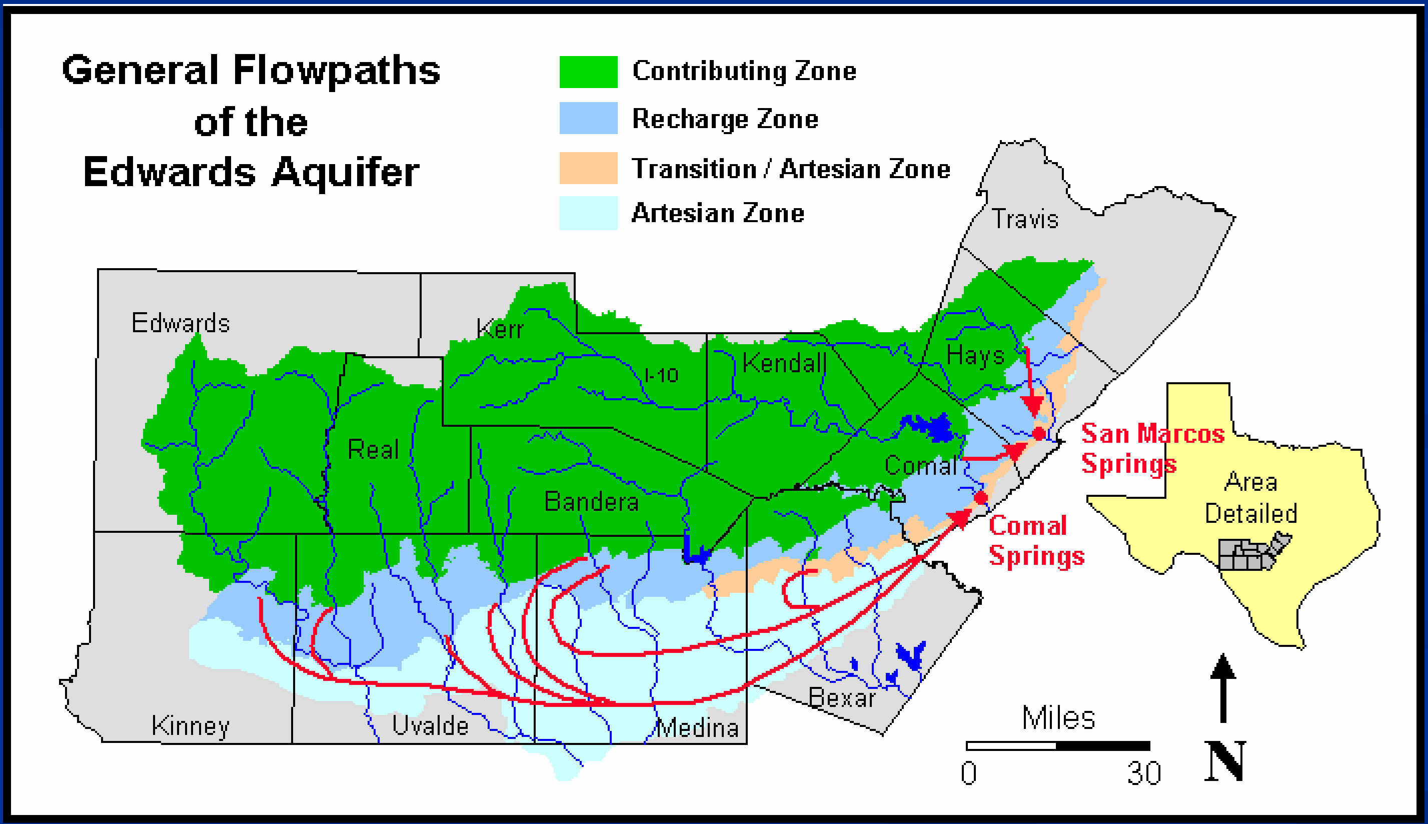
EAA Management (cont)



EAA Management (cont)



EAA Management (cont)



EAA Management (cont)

- EAA begins research to find answers
  - Lots of surprises
- Tracer Tests – changes thinking about sacred assumptions
  - Tracers race past barrier faults
  - Well head protection concepts are out
  - Behavior very different during drought

EAA Management (cont)

- Recharge appears under estimated
  - Begin using weekly NEXRAD data - cross checked with network of gages
  - Assemble system of ET towers
  - Recharge plots

EAA Management (cont)

- SWRI develops ModFlow model with “fast pathways” module to handle karst
  - “fast pathways” appear to dominate karst recharge
  - Raises new questions about land use in recharge and contributory areas

EAA Management (cont)

- Expanded use of hydrophysical logging to define location and limits of “fast” features
  - Well 608
    - 600 ft + depth
    - 350 gpm flows down hole
    - Quiescent during drought

EAA Management (cont)

- Modeling and research leads to rethinking southwestern reach of Edwards
  - Results in redefinition of Edwards structure and flows
  - May upset water markets
- Efforts may lead to "finding" of additional water in the Edwards

EAA Management (cont)

- EAA modeling attempts to honor aquifer structure
  - Aim is to develop model that is useful for daily management
  - Model needs to work as well at the springs as it does in the SW agricultural irrigation areas
  - Accuracy *vs* precision
  - Defensible

What's This Mean for Future of Montana Groundwater

- San Gabriel Basin and Edwards Aquifer systems were fully contained within respective state but
  - Federal Courts/Agencies dominate and drove management choices
  - Federal Courts/Agencies were used to fill vacuum
- Clark Fork Basin spans multiple states
  - Interstate water fights end up in Federal Courts

Future for Montana Groundwater (cont)

- How will Montana & Clark Fork Basin respond to increased competition for water?
- Any reason to expect Federal Court silence?
- Are existing regulatory structures adequate?
- Funding for legal fights adequate?
- Which is more likely
  - Passive San Gabriel approach?
  - Proactive EAA approach?

Questions??